Volume 26 Study G-III-K

STATE OF ALASKA

Bill Sheffield, Governor

Annual Performance Report for

POPULATION STUDIES OF GAME FISH AND EVALUATION OF MANAGED LAKES IN THE SALCHA DISTRICT WITH EMPHASIS ON BIRCH AND HARDING LAKES

by

Michael Doxey

ALASKA DEPARTMENT OF FISH AND GAME
Don W. Collinsworth, Commissioner

DIVISION OF SPORT FISH
E. Richard Logan, Director

TABLE OF CONTENTS

Study: G-III LAKE AND STREAM INVESTIGATIONS Page

Job: G-III-K Population Studies of Game Fish and Evaluation of Managed Lakes in the Salcha District with Emphasis on Birch and Harding Lakes.
by: Michael Doxey

TABLE OF CONTENTS (CONT'D) Page

LIST OF TABLES AND FIGURES

Volume 26 Study G-III

RESEARCH PROJECT SEGMENT

State: Alaska Name: Sport Fish Investigations of Alaska

Project: F-9-17

Study: G-III Study Title: LAKE AND STREAM INVESTIGATIONS

Job: G-III-K Job Title: Population Studies of Game Fish and Evaluation of Managed Lakes in the Salcha District with Emphasis on Birch and Harding Lakes

Cooperator: Michael Doxey

Period Covered: July 1, 1984 to June 30, 1985

ABSTRACT

This report presents the 1984 findings of studies on six stocked lakes in the Salcha District; information on the Salcha River chinook salmon, *Oncorhynchus tshawytscha* (Walbaum) sport fishery; and some information on winter studies in the Salcha River.

Second-year data are presented comparing Swanson strain rainbow trout, *Salmo gairdneri* Richardson, stocked as fingerlings in Birch Lake with three previous stockings of yearlings. Trout stocked as fingerlings in 1982 and 1983 showed poor survival, which precipitated a decline in catch per unit effort by the end of summer 1984.

Birch Lake creel-census data indicate that anglers spent 29,121 hours catching 11,806 rainbow trout and coho salmon, *Oncorhynchus kisutch* (Walbaum)--an overall catch per unit effort of 0.41 fish per hour.

Coho salmon stocked as fingerlings in Birch Lake attained catchable size by October and were contributing to the 1984-1985 winter fishery as young-of-year fish.

Data are presented on abundance, distribution and life history of fish present in Harding Lake. The first growth-data are presented on naturally produced lake trout, *Salvelinus namaycush* (Walbaum), that are progeny of fish stocked by the Department of Fish and Game in the late 1960s. Information is given on the stocking of sheefish, *Stenodus leucichthys* (Güldenstadt), in Harding Lake.

Data are presented on the status of coho salmon populations in Little Harding and Lost Lakes, on the rainbow trout in Koole and Spencer Lakes and on the sheefish experimentally stocked in Lost Lake.

KEY WORDS

Lake management, rainbow trout, lake trout, northern pike, sheefish, coho salmon, burbot, chinook salmon, angler effort, least cisco and Salcha district.

BACKGROUND

Salcha District

The Salcha District is bounded generally by the Salcha River drainage, the Tanana River upriver from its confluence with the Salcha River to the Little Delta River, and the Little Delta River and North Star Borough boundary (Fig. 1). The District contains two large lakes (Birch and Harding) and three small lakes (Little Harding, Lost, and Koole) that are stocked and accessible from the Richardson Highway. These lakes and the Salcha River provide excellent recreational potential for local residents and those from the Fairbanks area, Fort Wainwright and Eielson Air Force Base. At least two other small lakes in the District may offer sport fishing opportunities in the future.

Table 1 lists the common and scientific names and abbreviations of fish mentioned in this report.

Birch Lake

Birch Lake is an 803-acre lake located 56 mi southeast of Fairbanks on the Richardson Highway. The maximum depth of its lightly brown-stained waters is 49 ft.

The U.S. Air Force maintains a recreation camp on Birch Lake. Heavy summer use of this camp contributes significantly to angler pressure. There is a State parking and boat-launching area along the eastern shoreline and a turnoff and parking area where the highway passes the southern end of the lake. About half the shoreline of the lake is private land with cabins. The lake has four small inlets; the outlet has a structure that controls fish and water levels.

Chemical rehabilitation in 1966 removed humpback whitefish, least cisco, burbot, slimy sculpin and stunted northern pike. Fingerling rainbow trout were subsequently stocked. Since that time, a popular summer and winter sport fishery has been maintained by stockings of fingerling rainbow trout and coho salmon and subcatchable rainbow trout (trout too small to catch with hook and line).

Lake chubs and slimy sculpins have appeared in the lake, probably because the outlet structure was vandalized in 1967. The chubs have attained such

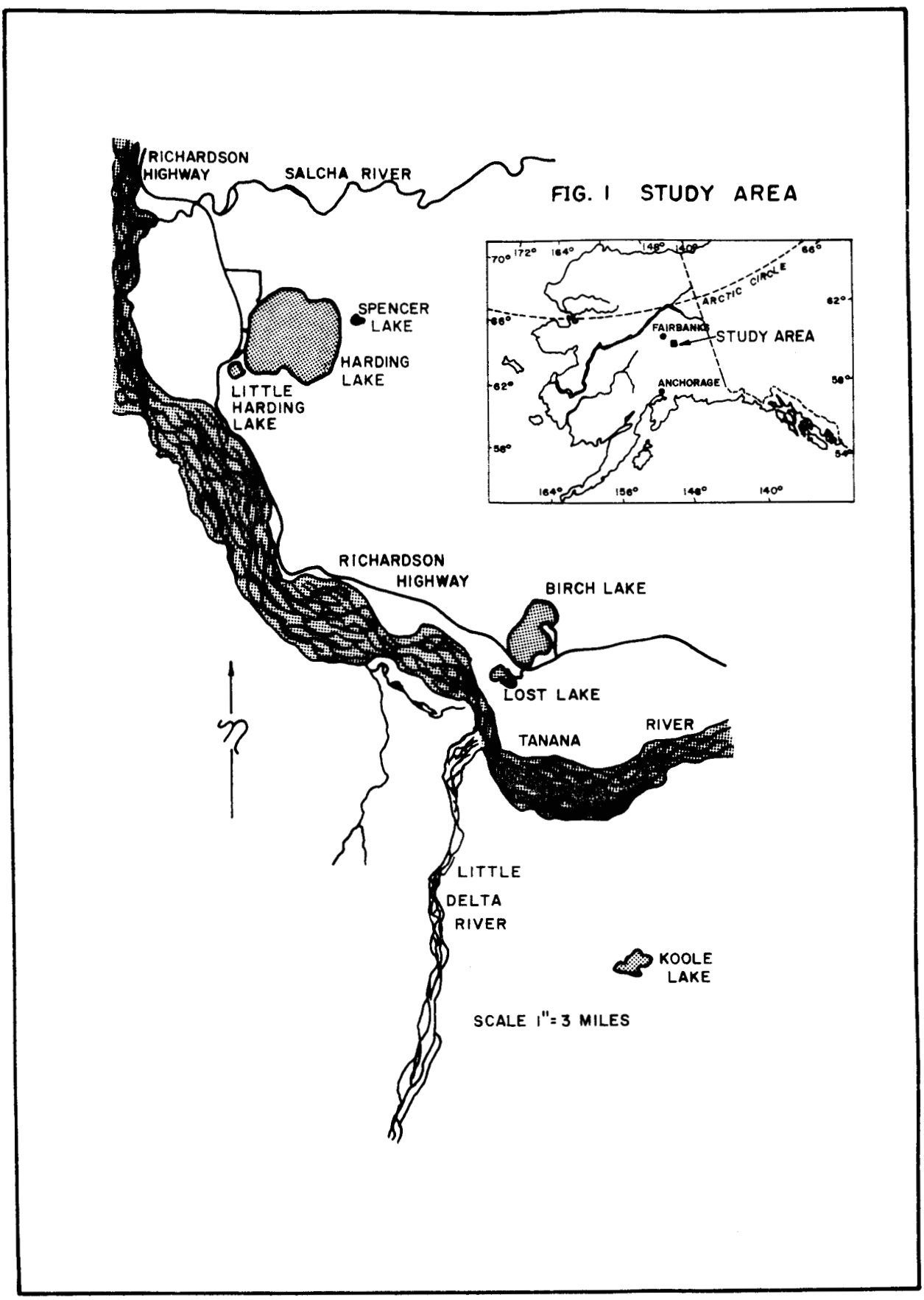


Figure 1. Delineation of study area.

Table 1. Scientific and Common Names of Fish Mentioned in This Report.

Common Name	Scientific Name	Abbreviation
Burbot	*Lota lota* (Linnaeus)	BB
Chinook salmon	*Oncorhynchus tshawytscha* (Walbaum)	KS
Coho salmon	*Oncorhynchus kisutch* (Walbaum)	SS
Humpback whitefish	*Coregonus pidschian* (Gmelin)	HWF
Inconnu (sheefish)	*Stenodus leucichthys* (Güldenstadt)	SF
Lake chub	*Couesius plumbeus* (Agassiz)	LC
Lake trout	*Salvelinus namaycush* (Walbaum)	LT
Least cisco	*Coregonus sardinella* (Valenciennes)	LCI
Longnose sucker	*Catostomus catostomus* Forster	LNS
Northern pike	*Esox lucius* Linnaeus	NP
Rainbow trout	*Salmo gairdneri* Richardson	RT
Round whitefish	*Prosopium cylindraceum* (Pallas)	RWF
Slimy sculpin	*Cottus cognatus* Richardson	SSC

a high population level that they compete with stocked game fish for both space and food.

An evaluation of the rainbow trout fishery in Birch Lake and a comparison of the stocking suitability of the Ennis-Alaska strain and the Swanson River strain rainbow trout were started in spring 1979, and studies of Swanson strain fish are continuing. The results, to date, are presented in reports by Doxey, (1980-1984).

Harding Lake

Harding Lake is located 45 mi southeast of Fairbanks along the Richardson Highway. The transparent-green, 2,470-acre lake has a maximum depth of 144 ft. There are two inlets but no visible outlet. Climatological trends and drainage changes from the mid-1960s to 1982 had lowered the level of the lake about 3 ft, drying up large areas of pike spawning and summer-rearing habitat at the northern end of the lake. By 1982 this trend had reversed and the lake was rising and flooding the flats at the northern end.

The indigenous fish in the lake include northern pike, burbot, least cisco and slimy sculpin. Lake trout planted in the lake in 1939, 1963 and 1965 as adults and in 1967 as fingerlings. Coho salmon fingerlings and smolts were stocked intermittently from 1968 until 1981. The contribution of stocking to the sport fishery has so far been negligible (Hallberg, 1979). Pike and burbot remain the basis of a light-intensity sport fishery in the lake. The results of fish-population-index and distribution studies conducted in conjunction with this project are presented in Doxey (1980-1984). In 1982, an experimental sheefish stocking program was begun with the planting of 141,735 fingerlings and 370 yearlings in the lake. Subsequent gill-netting has, to date, revealed little indication of their fate.

Little Harding Lake

Little Harding Lake is a 54-acre lake located adjacent to Harding Lake, 45 mi down the Richardson Highway from Fairbanks. The maximum depth of Little Harding Lake is 28 ft, the water is brown-stained, and the shoreline is swampy. The outlet empties into Harding Lake. There are control structures at both ends of the outlet to prevent fish movement.

Little Harding Lake was rehabilitated in 1966 to remove stunted northern pike and then stocked with coho salmon. Return of pike necessitated rehabilitation again in 1976, followed by the stocking of 48,400 coho fingerlings that same year. Kramer (1978) and Hallberg (1979) found very high survival of these fish; consequently, growth was slow. Stocking levels were subsequently decreased. Evaluation of the effect of decreased stocking levels continues, and the lake provides a popular winter fishery.

Lost Lake

Lost Lake is a 102-acre lake located 56 mi southeast of Fairbanks on the Richardson Highway, and a half mile southwest of Birch Lake. The

brown-stained waters have a maximum depth of 39 ft. A fish-control structure blocks the outlet.

Lost Lake has been rehabilitated three times (last in 1970). Stockings of coho salmon and rainbow trout have produced an intermittently successful sport fishery. Efforts to maintain the sport fishery have been somewhat thwarted by vandalism of the weir on the outlet stream; stocked fish escaped, and undesirable species entered the lake. In addition to stocked species, the lake is inhabited by lake chubs and longnose suckers.

Since 1979 the lake has been stocked with 10,000-30,000 coho salmon per year. Sport fishing effort is increasing.

Koole Lake

Koole Lake is a 320-acre lake lying in the Tanana Flats, 8 mi southeast of Birch lake, across the Tanana River. It has a large shoal area and a maximum depth of 22 ft. The water is transparent brown, and much of the shoal area supports lily pads and emergent aquatic vegetation.

Access to the lake is by snowmobile or light aircraft. An intermittent outlet is blocked by an old beaver dam. The land surrounding the lake is primarily military reservation, and there are no roads in the area.

Originally a barren lake, Koole Lake has been stocked with rainbow trout since 1975. Trout fishing has generally been excellent because of the rapid growth of the fish. Koole Lake has been used during the summer by at least two sport-fishing, guide services and numerous private pilots. Winter use by anglers traveling to the lake overland with snowmobiles, three-wheelers, and dog teams has been increasing, in part, because of Department efforts.

Spencer Lake

Spencer Lake is a brown-stained, 11-acre lake three-eighths mile east of Harding Lake. The lake has no apparent inlet. A small, swampy outlet drains toward Harding Lake. A survey in August 1979 revealed a population of small northern pike, which encouraged the staff to continue evaluating the lake for possible rehabilitation and stocking (Doxey, 1980).

Bathymetric and dissolved oxygen (DO) analyses were conducted in spring 1980 and 1981, and further information was collected on the northern pike population in the lake. In October 1982, the northern pike in Spencer Lake were eradicated with rotenone; in October 1983, 5,100 large rainbow trout fingerlings were stocked through the ice.

RECOMMENDATIONS

Management

1. Birch Lake should be managed as mixed rainbow trout and coho salmon sport fishery. A total of 50,000 coho salmon at 150 fish/lb (3.0 g

each) should be stocked in May 1985. A total of 75,000 rainbow trout at 20 fish/lb (23 g each) should be stocked in May 1986.

2. Koole Lake should be stocked annually with 30,000 rainbow trout at 200 fish/lb (2.3 g each).

3. Lost Lake should be maintained as a coho salmon sport fishery. A total of 5,000 coho salmon at 150 fish/lb (3.0 g each) should be stocked immediately after breakup.

Research

1. Evaluation of the survival and catchability of Swanson River strain rainbow trout in Birch Lake should continue, emphasizing trout stocked as subcatchables.

2. The evaluation of coho salmon growth, survival, catchability, and stocking practices in Lost and Little Harding Lakes should continue.

3. An experimental chinook salmon stocking program should begin in Little Harding Lake, with the stocking of 10,000 chinook fingerlings at 150 fish/lb (3.0 g each) in May 1985.

4. Methods of improving sport fishing in Harding Lake should be investigated, and studies of indigenous fish should be continued. The multiyear, sheefish-stocking experiment should continue with the stocking of large fingerlings in 1985. Index population studies should begin on burbot. Small-scale habitat-improvement studies should be undertaken.

5. Evaluation of the performance of rainbow trout stocked into Spencer Lake should continue. Experimental stockings should continue, as necessary and feasible, to create a sport fishery.

6. Rainbow trout growth and catchability in Koole Lake should be monitored to determine the effects of annual stocking.

OBJECTIVES

1. The performance of Age-I Swanson strain rainbow trout stocked as fingerlings into Birch Lake in 1982 and 1983 will be compared with the previously determined performance of Swanson strain rainbow trout stocked as Age-I subcatchables. Performance will be evaluated by:

   a) A statistically based summer creel-census program covering the Birch Lake rainbow trout sport fishery from breakup in May to late August 1984.

   b) A limited winter creel-census program covering the Birch Lake rainbow trout sport fishery from freeze-up in 1984 to breakup of 1985.

c) Monthly assessments of the growth of various age classes of Birch Lake rainbow trout with emphasis on Age-0, -I and -II fish.

d) A fall population estimate of the Age-I rainbow trout population of Birch Lake.

2. The Sport Fish Division has begun an experimental sheefish-stocking program in Harding Lake. This program will continue in 1984 with the addition of up to 500,000 large fingerlings (depending upon availability). The evaluation of these and of the 142,000 sheefish stocked as fingerlings in 1982 will be continued during the summer, fall and possibly winter of 1984.

   Interaction of stocked sheefish with the northern pike, burbot, lake trout and least cisco in the lake will be assessed by collecting fish from various habitats in the lake and noting the degree of interpredation. Growth and availability to the creel of stocked sheefish will be assessed as specimens become available. General information on the population levels, growth, and distribution of indigenous fish in Harding Lake will be collected.

3. An experimental sheefish stocking program will begin in Lost Lake with the introduction of 5,000 large fingerlings in August 1984. Interaction of stocked sheefish with the longnose suckers, lake chubs, stocked Arctic grayling and stocked coho salmon will be monitored. Specimens will be collected for growth and interpredation studies. Availability to the creel of stocked sheefish will be assessed as they become large enough to be taken by anglers. The reproductive potential of the Lost Lake sheefish population will be assessed as the fish mature in coming years.

4. Stocks of planted coho salmon in Little Harding and Lost Lakes and planted rainbow trout in Koole Lake will be evaluated in terms of growth, relative abundance, and angling potential to determine the results of the stocking program.

5. The assessment of the experimental stocking of rainbow trout into Spencer lake will continue. Based on 1984 findings, a decision will be made on when to again stock the lake and at what level. Growth and catchability of stocked trout and limnological conditions that may affect their survival will be monitored.

6. The Salcha River chinook salmon sport fishery and other sport fisheries in the District will be monitored as time allows. General studies of the distribution and life history of fish populations other than those specified in previous objectives may be undertaken.

TECHNIQUES

An electrofishing unit, based on the boat-mounted unit described by Van Hulle (1968) and Roguski and Winslow (1969), was used for obtaining part of the fish sample for the rainbow trout population estimate in Birch Lake.

Fyke nets, 20 ft long by 4 ft diameter, with 3/8-in. knotless nylon webbing and 100-ft by 4-ft center leads, were set along the shoreline of Birch Lake to capture fish for population estimates and growth studies.

For the Birch Lake rainbow trout population estimate, captured fish were marked by fin clips and released. Different fin clips were used in different areas of the lake to determine the degree of mixing. Numbers of marked and unmarked fish were tabulated upon recapture, and population estimates and confidence limits were determined using Schnabel multiple mark and recapture estimates.

We used monofilament gill nets (140 ft by 6 ft with seven 20-ft panels of 0.5-2.5 in. bar mesh) and multifilament and monofilament sinking or floating gill nets (125 ft by 6 ft with five 25-ft panels of 0.5-2.5 in. bar mesh) to monitor fish populations in Lost, Harding, Little Harding, and Koole Lakes. Gill nets were set at different depths and in different habitats on both the bottom and surface. Fish were occasionally collected by angling.

For growth studies, Birch Lake rainbow trout and coho salmon samples were collected monthly; coho salmon were collected in Lost and Little Harding Lakes twice during the open-water season. Koole Lake rainbows were collected in June. The fish were measured to the nearest millimeter of fork length and weighed to the nearest gram on a triple-beam balance or Chatillon IN-2 spring scale. Larger fish were weighed on a Chatillon IN-25 spring scale. Fish scales used for age determination were either individually cleaned and mounted between glass slides or impressed on 20-mm acetate using a Carver press at 20,000 16/in.^{2}, heated to 200°F for 30 seconds. The scales were read on a Bruning 200 microfiche reader. Northern pike, burbot, lake trout, and least cisco from Harding Lake were sampled, as appropriate. For aging, otoliths were collected from burbot and lake trout, and cleithra were collected from pike.

Birch Lake nearshore-water temperatures were recorded continuously through most of the summer by a Ryan thermograph. Thermograph temperatures were calibrated and verified through spot checks with conventional thermometers. Winter DO levels and water-temperature profiles were determined with a YSI dissolved-oxygen meter.

A summer creel-census program was started at Birch Lake. Weeks were stratified according to predicted intensive-use periods on Saturdays, Sundays and holidays, and predicted light-use periods on weekdays. Two angler counts were taken during randomly selected weekend-use periods; at least once a week, counts were taken during randomly selected weekdays. Two or three counts were made during holiday-use periods. Immediately after one of the weekend angler counts, most or all of the anglers were

interviewed. Notes were made on the number and size composition of rainbow trout in the catch and the time spent angling.

A limited creel-census was also conducted in winter at Birch Lake. Similar information was gathered. For organizing the creel-census data, a fishing year was defined as the period from freeze-up (November) of one year through the end of August of the next. Angler effort is very low from early September to freeze-up, and no creel-census was undertaken during this period.

The instantaneous angler counts were expanded to yield an estimate of angler effort during the use periods. These estimates were then adjusted for known weather condition and hours of daylight to obtain the final estimate. Catch-per-unit-effort (CPUE) data, expressed as fish per angler hour, were obtained from the interviews. For previous years' creel-census data are included in Doxey, (1980-1984).

The chinook salmon sport fishery on the Salcha River was monitored, as time allowed, by boating to the area where fishermen concentrated, making a count and interviewing most or all of the anglers about their catch, angler hours, and previous catch. A sport-fishing charter service on the Salcha River also provided valuable information.

Notes were taken on catch whenever we found anglers fishing where there was not an organized creel census.

Rainbow trout fingerlings in 17-gallon coolers were transported by float plane from Birch Lake to Koole Lake. About 2,800 trout were carried in each cooler (about 1 lb of fish per gallon of water). Supplemental oxygen was provided. A medical regulator on the oxygen tank supplied oxygen through a plastic tube to an aquarium gang-valve from which a line led to an air stone in each cooler.

FINDINGS

Birch Lake

Stocking:

Birch Lake stocking in 1984 began on May 24 when a total of 50,000 coho salmon at 120 fish/lb (3.8 g each) were planted. The coho salmon, provided by Clear Hatchery, were in excellent condition: only one dead fish was noted.

On July 25, a total of 264,998 Swanson strain rainbow fingerlings at 262 fish/lb (1.7 g each) were planted. They had been reared at the Elmendorf Hatchery. About 500 fingerlings died as a result of problems with the tank valves. An additional 3,000-5,000 fingerlings (estimated by volumetric sampling) died in the lake--apparently, as a result of fed and unfed fish being transported together in some of the tanks. The fish from tanks which had contained only unfed trout appeared to be in good condition. A flock of gulls congregated, but they appeared to be feeding only on dead or dying trout.

A plan to stock half of the trout at one location and half at another was not implemented because rainy weather had made the road to the second location too muddy. All of the trout were stocked in the southern end of the lake.

Creel Census, Fishing Year 1984:

A limited, winter creel census was conducted, and data were expanded to cover the period from November 2, 1983 to April 29, 1984. After this, most ice fishing had ended because the ice started to break up and the Department requires all fishing shanties be removed by April 30. In midwinter, 35 shanties were in use on Birch Lake. A total of 259 anglers were interviewed. The greatest number of anglers seen on the lake was 108 on February 15. Weekend counts averaged 39 anglers; weekday counts ranged from 0 to 7 anglers.

Overall CPUE was 0.59 fish/h (range, 0.27-3.75 fish/h). Catches were best in early and midwinter and declined toward spring.

Winter anglers spent an estimated 11,865 hours to catch an estimated 7,001 rainbow trout and coho salmon. Trout stocked as subcatchables in 1982 made up the highest percentages (42%) of the catch (2,966 fish at 0.25 fish/h). A total of 1,780 (0.15 fish/h) trout, stocked as subcatchables from the Clear Hatchery in 1983, were taken. The rest of the catch was comprised of 1,305 (0.11 fish/h) yearling trout from fingerling stocked in 1982, 712 older trout stocked in 1981 and earlier years (0.06 fish/h), and 238 coho salmon stocked in 1981 and 1982 (0.02 fish/h). The rainbow trout catch declined slightly from that of the previous winter. The most noticeable reason was yearling trout stocked as fingerlings in 1982 failed to provide good numbers of fish to the fishery. The winter catch of 1,305 yearlings in fishing year 1984 was much lower than winter catches of yearlings from similar stockings of subcatchables from 1979 to 1982, which had catch ranges of 2,882 to 9,221 yearlings (Doxey, 1984).

Overall CPUE was also affected by the decline of the coho population in the lake. Age-III coho salmon remaining from the 1980 plant were dying off, as were many Age-II males from the 1981 plant.

The 1984 summer creel census covered the period from May 20 to August 31. A total of 238 anglers were interviewed. The number of anglers seen during weekend counts ranged from 2 to 81. Anglers spent an estimated 17,256 hours catching an estimated total of 4,803 rainbow trout, an overall CPUE of 0.28 fish/h. Effort was about the same as in the previous three summers (Table 2), but catch declined sharply because of the minimal contribution from Age-II rainbow trout stocked as fingerlings in 1982 and no contribution from Age-I trout stocked as fingerlings in 1983. Table 3 compares summer rainbow trout fisheries for the years 1979-1984. In Table 3, all of the harvested Age-I fish were stocked as subcatchables.

Table 4 gives details of the 1984 summer creel census. Larger, older trout made up almost half of the harvest. Effort during the season shows the influence of very good weather in June, followed by a cold, rainy weather in July. Weather improved somewhat in August.

Table 2. Total Effort and Catch per Unit Effort (CPUE) of 1979-1984 Summer Fisheries for Birch Lake Rainbow Trout.

Dates	Total Catch	Angler-Hours	CPUE (Fish/h)
May 27 - Sept. 3, 1979	4,473	16,324	0.27
May 19 - Sept. 1, 1980	7,602	22,290	0.34
May 11 - August 30, 1981	9,932	17,974	0.55
May 28 - Aug. 29, 1982	7,897	17,058	0.46
May 19 - August 31, 1983	9,390	17,806	0.53
May 20 - August 31, 1984	4,803	17,256	0.28

Table 3. Comparison of Catch, by Age-Class, of Rainbow Trout in Birch Lake for Summer, 1979-1984.

Date	Age III & Older		Age II		Age I	
	Number	Percent	Number	Percent	Number	Percent
May 27 - Sept. 3, 1979	Combined with Age II		3,053	68.0	1,420	32.0
May 19 - Sept. 1, 1980	890	12.0	5,015	66.0	1,697	22.0
May 11 - August 30, 1981	53	0.5	5,068	51.0	4,811	48.5
May 28 - August 29, 1982	1,446	18.0	6,451	82.0	0	0
May 19 - August 31, 1983	2,042	22.0	5,870	62.0	1,478	16.0
May 20 - August 31, 1984	2,113	44.0	2,690*	56.0	0	0

* 1,315 fish stocked as subcatchables in June 1983 from the Clear Hatchery and 1,375 trout stocked as fingerlings in August 1982.

Table 4. Birch Lake Summer Creel Census. Estimated Fishing Effort and Catch Statistics, by Species and Age-Class, 1984.

Period	Hours Fished	CPUE (Fish/h)	Coho Salmon		Rainbow Trout								Total Number
					Age III* and Older		Age IIa** and Older		Age II b+ and Older		Age I# and Older		
			No.	%	No.	%	No.	%	No.	%	No.	%	
5/20-7/1	8,670	0.25	0	...	1,300	60	780	36	87	4	0	...	2,167
7/2-7/29	3,977	0.28	0	...	398	36	318	28	398	36	0	...	1,114
7/30-8/31	4,609	0.33	0	...	415	27	277	18	830	55	0	...	1,522
Totals	17,256		...	...	2,113	44	1,375	29	1,315	27	0	...	4,803
Mean fish/h, by age class and species.			0		0.12		0.08		0.08		0		0.28

* Primarily Swanson strain fish stocked during or before 1981 or stocked as yearlings in 1982.

** Swanson strain fish stocked as fingerlings in 1982.

\+ Swanson and Big Lake strain trout stocked as yearlings in 1983.

\# Swanson fingerlings stocked in 1983.

The combined winter and summer totals for fishing year 1984 are compared with previous years in Table 5. Anglers spent an estimated 29,121 hours catching 11,806 rainbow trout and coho salmon, an overall CPUE of 0.41 fish/h.

Rainbow Trout Population Estimate:

In early October 1984, a population estimate of Age-I rainbow trout stocked as fingerlings in 1983 was conducted. As in fall 1983, the target trout were too small to be effectively stunned by electrofishing and were not numerous enough to make night shocking worthwhile. Fyke netting did produce some consistent results. Five days of netting and fin clipping produced a total of 617 marked yearlings. This result was better than the 441 yearlings marked during 1983, but still far less than the average of 2,215 yearlings marked during 1979-1982, when survival to fall of trout stocked as subcatchables was being estimated. The rate of crossover (fish being recaptured across the lake from where they had been marked) was over 50% in some cases, which indicated the best mixing of marked and unmarked trout ever noted.

The recapture rate yielded an estimated population of 2,727 yearling rainbow trout (95% confidence limits, 2,239-3,398 fish). This represents a mean survival to catchable size of 2.18% (range, 1.79%-2.72%) of the 125,000 fingerlings stocked in late summer 1983. Similar results were derived from the fall 1983 population estimate of fingerlings stocked in 1982; at the time, the 1983 estimate was dismissed as unreliable because of gear problems (Doxey, 1984). The 1984 results lend some credence to low survival estimates in 1983. Other indicators of low fingerling survival and a consequent decline in the population of catchable trout in Birch Lake are: (1) the high proportion of larger, older trout entering the creel during summer 1984 (smaller trout from fingerling stockings should have been the most frequently caught fish), (2) the rapid growth of coho salmon stocked in May 1984 (discussed later), (3) overall fyke-net catches of catchable-size rainbow trout were lower than during years when the sport fishery was being supported by stockings of subcatchables, and, (4) CPUE has declined rapidly (discussed in the creel-census section).

Discussion:

All of this evidence has resulted in the management recommendation that the Department stock 20 fish/lb (23 g each), subcatchable rainbow trout in Birch Lake. In other lakes (Koole, Bluff Cabin), Swanson strain fingerlings appear to be contributing to the fishery quite well; however, in the case of Birch Lake, they do not. Further experimentation with fingerlings in Birch Lake might produce better results, but the interests of the sport angler are not well served: the declining CPUE for rainbow trout from past fingerling stockings could occur during future experiments. Plants of Swanson subcatchables (20 fish/lb; 23g each) in 1980 and 1981 had more than 50% survival to catchable size (Doxey, 1981 and 1982) and resulted in a much higher CPUE (Table 5) when these year-classes were supporting the fishery.

Table 5. Fishing-Year Totals from Combined Winter-Summer Birch Lake Creel Census. Contributions of Year-Classes.

Fishing Year	Hours Fished	CPUE (Fish/h)	Rainbow Trout Caught									
			1978 & Older	1979	1980	1981	1982a*	1982b**	1983a+	1983b#	Coho° Salmon Caught	Total
Dec. 1, 1979 - Sept. 1, 1980	34,921	0.52	2,027	14,236	1,697	...	...	...	...	...	...	17,960
Nov. 23, 1980 - Aug. 30, 1981	29,933	0.79	241	2,682	13,081	4,811	...	...	...	...	2,832	23,647
Nov. 21, 1981 - Aug. 31, 1982	28,999	0.80	0	50	2,640	15,645	0	0	...	...	4,658	22,993
Nov. 7, 1982 - Aug. 31, 1983	29,336	0.85	0	0	1,366	4,711	8,752	38	1,440	...	8,670	24,977
Nov. 2, 1983 - Aug. 31, 1984	29,121	0.41	...	...	...	1,122	4,669	2,680	3,095	0	240	11,806

* Stocked as subcatchables in 1982.
** Stocked as fingerlings in 1982.
\+ Stocked as subcatchables in 1983.
\# Stocked as fingerlings in 1983.

° From the combined 1980-1981 stockings.

Rainbow Trout Growth:

Seventy-one yearling rainbow trout from the 1983 stocking of Swanson strain fingerlings were sampled for length in October 1984. Mean length was 180 mm (an increase of 128 mm from stocking size and an increase of 66 mm from early July 1984). The fish stocked in 1983 grew slightly faster and were 14 mm larger than the fish stocked in 1982 and growing during the equivalent period. Thus, the fish stocked in 1983 had reached catchable size at freeze-up 1984, and a few of them entered the winter fishery. Length data for Age-I rainbow trout in Birch Lake are presented in Table 6.

Fork lengths of the larger, older trout available to anglers ranged up to 480 mm (as evidenced by fish measured during the October population estimate).

Coho Salmon Growth:

In 1984, two year-classes of cohos were present in Birch Lake. In early October 1984, a total of four terminal-year coho salmon from the 1981 stocking were sampled for length and weight. Mean fork length was 412 mm (range, 402-423 mm) and mean weight was 900 g (range, 875-950 g). This represents much better growth than the 1980 coho salmon exhibited (318 mm mean length in their terminal year: Doxey, 1983).

Growth of the coho salmon stocked in May 1984 was exceptionally good probably because of the high quality of coho salmon from the Clear Hatchery and the low density of other sport fish in the lake during summer 1984. The fish grew from 70 mm in May to 181 mm in October (n = 71); thus, the 1984 stocking attained catchable size after one summer. The coho salmon stocked in 1980 grew from 63 mm at stocking to 112 mm in September (n = 35). In January 1985, the coho salmon stocked in 1984 provided 75% of the harvest in the Birch Lake winter fishery, and the overall CPUE was over 1.0 fish/h.

Limnological Information:

The 1984 open-water season on Birch Lake extended from breakup on May 21 to freeze-up on October 18. Average weekly water temperatures peaked at 68°F in late June, then declined in response to a very wet, cool July. The lake rose rapidly during several rainy spells, and the outlet structure had to be completely opened to keep the water level below the legal water mark. Good fall weather resulted in higher than usual temperatures in early October, just preceding the rapid decline to freeze-up (Fig. 2). Maximum ice thickness during winter 1983-1984 was 34 in.

Harding Lake

Fish Stocking:

From June 4 through June 13, a total of 211,641 sheefish (69 fish/lb; 6.6 g each) were stocked into Harding Lake. Mean length of a sample of 22 fish was 89 mm (range, 72-105 mm). The fish were transferred from the hatchery truck to barrels in a boat and distributed over deep water in all

Table 6. Length Data for Age-I Rainbow Trout Stocked in Birch Lake Since 1979.

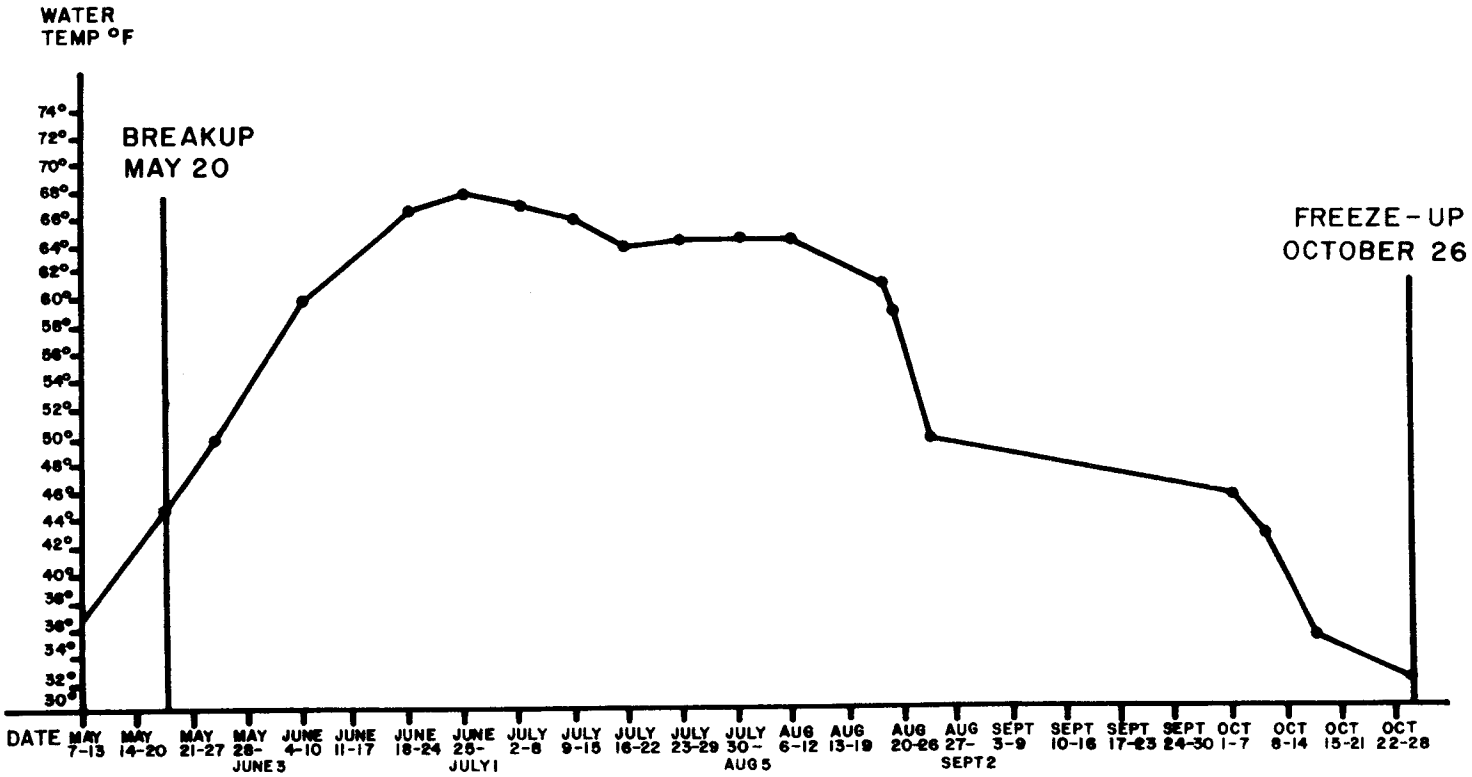
Date Stocked	Brood Stock	Mean Fork Length (mm)	
		At Stocking	Fall of First Full Summer
5/21/79	Ennis-Alaska	127	225
5/23/80	Swanson River	130	179
5/20/81	Swanson River	125	188
6/08/82	Swanson River	85	154
8/23/82	Swanson River	46	166
8/29/83	Swanson River	52	180

FIGURE 2

AVERAGE WEEKLY SURFACE WATER TEMPERATURES

BIRCH LAKE 1984

NEARSHORE AREA



areas of the lake and in some shallower water where northern pike were not abundant. The sheefish were provided by the Clear Hatchery and were in excellent condition. Initial mortality was minimal and, in most cases, was the result of mechanical injury during stocking. About 100 sheefish were placed in a holding pen in a sheltered, nearshore area. After 24 h, none had died. All but 20 fish were released. These 20 fish were held for six more days, and none died. Water temperature, initially 54°F, had risen to 63°F by the end of the experiment.

Test Netting and Life-history and Species-Distribution Information:

Test netting in 1984 was conducted with three general goals:

1. Determine the status of stocked sheefish,

2. Monitor seasonal index areas to gather information on indigenous species, and

3. Gather seasonal fish-distribution information.

The nets were fished a total of 42 net nights from early to mid-June, throughout July into early August, in late August and in mid-October. Depths fished ranged from 6 ft to 120 ft. Prime northern pike habitat was usually avoided, but pike were sometimes netted to examine their stomach contents.

The following information was derived from observations, test-netting results, and analysis of other information.

Sheefish:

The 20 sheefish held in the holding pen for a week were killed and examined to determine whether they had been feeding. Eight had empty stomachs; the rest had fragments of aerial insects in their stomachs and guts. The one sheefish found in a northern pike stomach in mid-July also had aerial-insect fragments in its stomach. Young-of-the-year least ciscos, which were extremely abundant in Harding Lake in summer 1984, could be an excellent food source for the young sheefish. The ciscos were small enough for sheefish to prey on them throughout the summer.

During the open-water season, the stomach contents of 53 northern pike, 15 burbot, and 11 lake trout were examined. Of the eight pike examined in mid-June, two had eaten eight sheefish and one had eaten nine sheefish. The rest had empty stomachs. One sheefish was found in a pike stomach in mid-July. None were found in any of the other pike, or in the burbot or lake trout captured.

Gulls were attracted to the schools of sheefish from the moment they were stocked and ignored large schools of similar-sized ciscos that were observed in the same locations as the sheefish. The least ciscos have a dark-green back when seen from above, in contrast to the light, almost iridescent, back of the sheefish. This may have caused the gulls to target on the sheefish. When we could closely observe the feeding gulls

(including one instance when they were feeding on a large number of recently-stocked sheefish in less than 16 in. of water), they did not appear to have a high success rate. Probably in less than one of ten strikes did the gulls catch a fish. Flocks of at least 40 gulls were feeding along the shallows through late June, after which the sheefish apparently moved out over deeper water. The gulls were seen feeding over deep water until late July, when their intensive feeding activity ceased.

A total of three sheefish were taken in nine net nights of gill netting effort in early and mid-June, during and just after the time that sheefish were stocked.

Test netting in July produced no sheefish. Sets of four gill nets placed in line, on the bottom, in depths from 20 ft to 120 ft in four quadrants of the lake in late August produced no sheefish. In mid and late summer, we could always locate schools of fish along the thermocline (at about 30 ft) over deep water, with a recording fathometer, but gear was not available to sample that zone. Most of these fish were probably least ciscos. In 1985, midwater habitats of Harding Lake will be sampled with vertical gill nets.

In summary, the sheefish fingerlings disappeared from the nearshore and surface waters of Harding Lake by late July. The population that is surviving remains to be evaluated.

Lake Trout:

In 1984, lake trout were netted at depths ranging from 25 ft to 80 ft. Four large specimens were alive and were released. Of a total of 11 fish sampled, 10 fish wre from natural reproduction in the lake. Table 7 presents mean weights and lengths and maturity data for all native lake trout taken since the first one was netted in 1981. The maturity data indicate that second-generation spawning may be beginning. The small sample taken to date indicates fast growth of young lake trout in Harding Lake.

Alt (1977) compared age-length data for three Kuskokwim drainage lakes and also compared these growth rates with data from Paxson Lake (Van Wyhe and Peck, 1968) and Great Bear Lake (Miller and Kennedy, 1948). The age-length data points of the trout in Table 7 lie well above the ranges reported by Alt. The trout were all in excellent condition, and the older ones had heavy visceral fat. Identifiable stomach contents consisted of least ciscos, slimy sculpins and, in some of the smaller trout, insect remains.

One of the five lake trout tagged in 1983 was recaptured. This fish had survived gill-net capture from a depth of 45 ft, tagging, weighing, and being released in poor condition. In the course of a year, this male lake trout's weight had increased from 4,200 g to 4,850 g.

Burbot:

Seventeen burbot were netted in Harding Lake in 1984. All were taken in July and August. Fork-length range of the 15 fish sampled was 250-893 mm. Mean length was 411 mm. Depths at which the burbot were taken ranged from

Table 7. Length, weight and age data for lake trout produced by natural reproduction in Harding Lake, 1981-1984.

Date Captured	Length (mm)	Weight (g)	Age	Sex	Maturity
07/22/83	110	104	II	Male	Developing
08/06/82	262	183	III	Male	Developing
08/24/84	268	220	III	Male	Developing
08/22/84	280	250	III	-	Developing
08/24/84	293	310	IV	Female	Developing
08/24/84	340	515	IV	Female	Developing
08/24/84	347	560	III	Male	Developing
08/23/84	487	1,700	VI	Female	Developing
10/15/81	585	2,340	VII	Female	Developing
08/24/84	589	3,350	VIII	Female	Developing
08/05/82	596	3,400	VII	Female	Prespawner
07/26/83	616	3,675	VII	Female	Prespawner
08/23/84	625	3,850	VIII	Male	Ripe
07/22/83	629	3,480	VI	Female	Developing
08/24/84	636	4,200	VIII	Male	Ripe
08/23/84	738	4,850	XI	Male	Ripe

25 ft to 100 ft. Stomach contents consisted predominantly of slimy sculpins; some least ciscos were also present.

Least Cisco:

Least ciscos were again abundant in Harding Lake in 1984. Large numbers of young-of-the-year ciscos occupied the shallow, vegetated, shoal areas of the lake from breakup to late June. Mean fork length of seven ciscos measured on May 22, 1983 was 10 mm (Doxey, 1983). Mean length of 16 fish measured on June 18, 1984 was 20 mm. Schools of adult ciscos were in the shallows throughout the period when the young-of-the-year ciscos were present, presumably feeding on them. Periodically through the summer, large concentrations of adult ciscos were observed surface feeding over deeper water.

Overall experimental-gill-net catch per net night ranged from 0 to 200 ciscos. Mean catch for the 42 net nights was 17.8 ciscos. In late August, large concentrations of ciscos were found occupying depths of 50-90 ft in the southeastern quadrant of the lake, and mean catch per net for five 24-hour sets was 92 fish. Many of these ciscos were ripe, indicating that spawning can begin in late August. Test netting in previous years had produced spawning ciscos just before freeze-up in October. Thus, spawning timing is either highly variable or there is an extended spawning period.

All but fifteen of the ciscos were in the 129-165 mm size range (Ages I-III). The other fifteen fish were larger, older fish that were as long as about 250 mm.

Northern Pike:

Of a total of 73 northern pike captured through the summer, 20 fish were released and 53 fish were autopsied. Complete mean weight and lengths and maturity data were recorded for a subsample of 36 fish. The balance were sampled only to determine whether they had been preying on sheefish. Length of the 36 fish in the subsample ranged from 156 mm to 842 mm; mean length was not determined. An effort was made to release larger pike if they were alive in the net, while small and medium sized specimens were more likely to be sacrificed. Ages of the subsample ranged from Age I to Age XII. Of the 53 pike stomachs examined through the summer, only 3 stomachs contained sheefish.

Baseline mean weight and length data are being gathered on Harding Lake northern pike. More life-history information will be presented as sufficient amounts are accumulated.

Little Harding Lake

Fish Stocking:

On May 25, 1984, a total of 10,000 coho salmon at (120 fish/lb 3.8 g each) were stocked in Little Harding Lake. They were provided by the Clear Hatchery and were in excellent condition. Stocking mortality was minimal.

General Information:

In 1984, Little Harding Lake contained two age-classes of coho in addition to the fish that were stocked that summer. The lake was sampled by gill net on June 12 and by angling on November 1.

Young-of-the-year coho salmon had a mean length of 70 mm at stocking. Three young-of-the-year fish taken by angling in November had a mean length of 130 mm. Age-I fish from the 1983 stocking grew from 131 mm (n = 50) in June to 184 mm in November (n = 11). Age-II fish from the 1982 stocking had a mean length of 176 mm (n = 6) in June. Two taken in November were 220 mm and 221 mm in length. Little Harding Lake provided excellent fishing in late 1983 and early 1984: catches of 3-5 fish/h were commonly observed for the anglers using the lake.

Lost Lake

Fish Stocking:

On May 24, 1984, a total of 5,000 coho salmon at 120 fish/lb (3.8 g each) were stocked into Lost Lake. They were provided by the Clear Hatchery and were delivered in excellent condition. This stocking was followed on June 7 by the stocking of 5,000 sheefish fingerlings at 69 fish/lb (6.6 g each). The sheefish were also in good condition, and mortalities were negligible. The low number of coho salmon stocked (compared to previous levels of 10,000-60,000 fish/year) was the result of a decision to maintain a smaller coho fishery while reducing competition for the experimentally stocked sheefish.

General Information:

A total sampling effort of five net nights with 140-ft, monofilament, graduated-mesh gill nets and two net nights with a fyke net was expended from June 12 until freeze-up. Two sheefish fingerlings were captured on June 12, 5 days after stocking. After that, none of the sheefish fingerlings released in 1984 were captured. Small numbers of lake chubs and longnose suckers and a total of 113 coho salmon made up the balance of the net catch.

The only other sheefish captured in Lost Lake was a 10-lb, mature, Age-VII male taken in late October by an ice fisherman. Its age indicated it was progeny of sheefish fry stocked in 1972, some of which apparently survived to spawn in 1976.

In addition to the fish stocked in May and June 1984, there were two age-classes of coho present in Lost Lake through the summer of 1984. Terminal-year cohos from the 1981 stocking had a mean fork length of 294 mm (n = 3; range, 173-210 mm) in October. Cohos from the 1982 stocking grew from 192 mm (n = 15; range, 173-210 mm) in June to 253 mm in October (n = 11; range, 225-271 mm). The mean length of 1984 coho salmon at stocking was 70 mm. Mean length of five of these fish netted in October was 142 mm (range, 117-169 mm). This may only represent the larger fish in the population of 1984 fingerlings, which can be taken with a 0.5-in.-mesh gill net.

Koole Lake

Fish Stocking:

On August 27, 1984, a total of 28,777 rainbow trout at 163 fish/lb (2.8 g each) were stocked into Koole Lake. The fish were transferred from a hatchery truck at Birch Lake to Koole Lake by float plane. The fish arrived at Koole Lake after a 10-minute flight and were stocked in good condition and with minimal mortality, with the exception of one group: the oxygen line to their tank became unhooked in flight. These fish were lethargic but appeared to be recovering after entering the lake.

General Information:

Rainbow trout in Koole Lake were collected by hook and line on February 29, 1984 and by angling and gill net on June 19, 1984. Trout collected in February were, with one exception, from the 1982 stocking of Swanson fingerlings. The fork length range of the 1982 fish was 199-265 mm (mean length, 230 mm); n = 32. Males comprised 76% of the sample, and 88% of them were ripe. The females (n = 8) were immature. All but eight of the trout had food in their stomachs. Food items included caddis nymphs, clams, snails, water beetles, and zooplankton. The only larger trout taken was a 436-mm, Age-III male. The CPUE during the February angling trip was 3.24 fish/h. Ten fish from the 1982 plant and two fish from the 1980 plant were collected in June. Mean length of the fish planted in 1982 was 290 mm (range, 235-345 mm); the two fish planted in 1980 were 430 and 520 mm in length.

Koole Lake was used by four air-charter or fishing-guide services and a number of private pilots during the summer of 1984. Angling was reported to be excellent.

Spencer Lake

Limnological Observations:

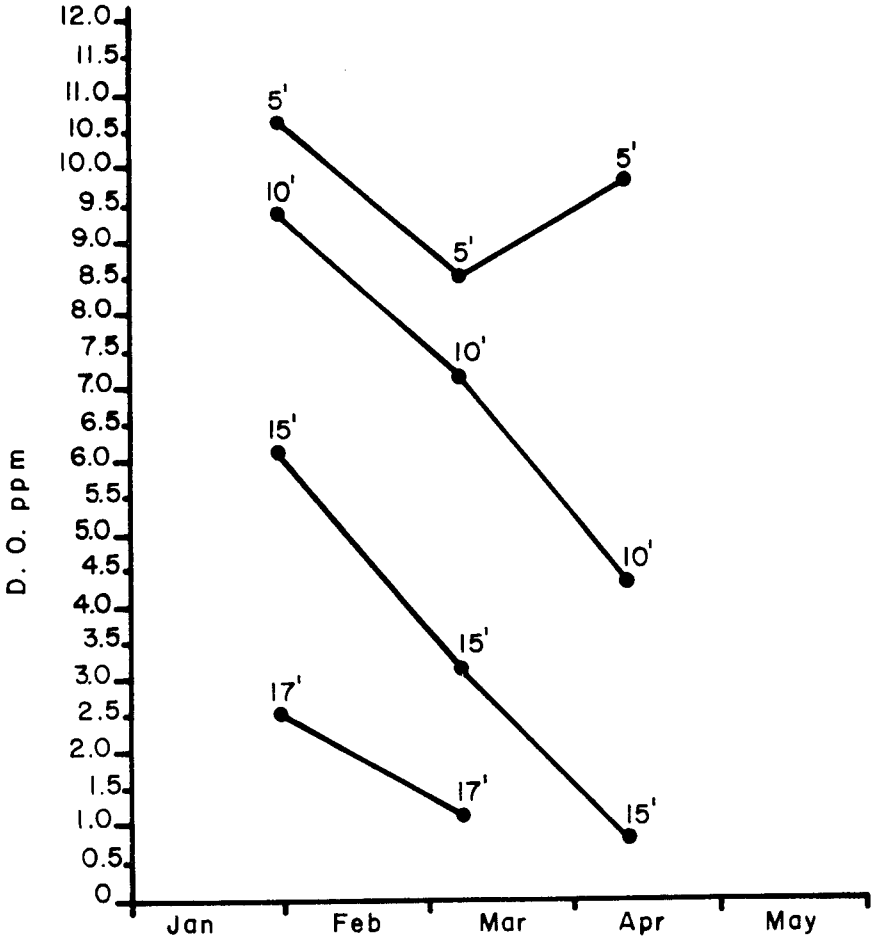
Dissolved oxygen levels were stable in Spencer Lake during winter 1983-1984 (Fig. 3). Oxygen was not a limiting factor at the index location, in 18 ft of water, in the southeast corner of the lake. The lowest DO level recorded in the more highly oxygenated zone, just under 37 in. of ice was 8.5 ppm, on March 9. By April 9, DO in this zone had increased to 9.8 ppm. The zone of low DO moved up steadily from the bottom throughout the winter, constricting trout habitat to an unknown degree. By May 13, the ice was breaking up and DO levels were no longer a potential problem. On April 2, 1980, DO levels ranged from 2 ppm to 4.5 ppm. Monitoring of winter DO in future years will establish the range of DOs that occur in the lake in the winter and during poor years, may provide data on the lower ranges of DOs at which stocked Swanson rainbow trout can survive.

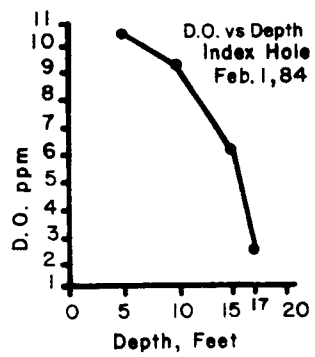
Spencer Lake Rainbow Trout:

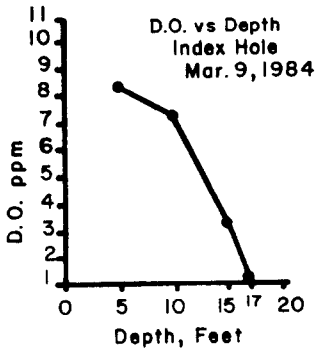
On March 9, 1984, we tried to capture Spencer Lake trout, using conventional ice-fishing gear. Bait (salmon eggs) was repeatedly stolen

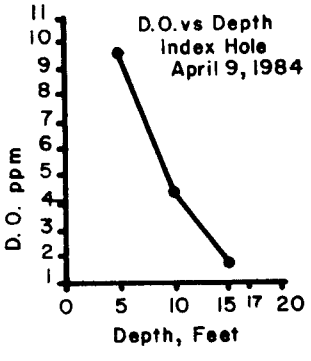
Figure 3

Spencer Lake Winter Dissolved Oxygen Levels
at Index Location 1984









off the hook, indicating that some fish were present and feeding but were too small to hook.

On August 1, an overnight set of the three smallest mesh (½-in., 5/8-in. and 3/4-in. bar mesh), 20-ft panels of a 140-ft, monofilament gill net produced 53 rainbow trout. Mean fork length was 164 mm, (range, 129-206 mm). Mean weight was 59 g (range, 25-118 g).

On November 16, 50 minutes of angling produced eight trout (9.64 fish/h). Length range was 166-229 mm (mean length, 189 mm), and weight range was 50-110 g (mean weight, 73 g).

The experimental stocking was successful, at least into the winter 1984-1985. Dissolved oxygen levels, growth, and catchability will be monitored through the winter and into the summer of 1985. Possibly by winter 1985-1986, sport angling by the general public will begin on Spencer Lake.

Salcha River

Chinook Salmon Fishery:

In 1984, the sport fishery for Salcha River chinook salmon began on July 9 and was over by August 1. July 1984 was unusually cool and rainy. During 5 days of the run, the river was unfishable because the river was high and turbid and rain fell during 14 days of the run. Commercial Fish Division biologists were unable to assess the Salcha River chinook escapement during the peak of the run, but they did get a minimum escapement count of 1,031 live and dead chinook salmon on August 8.

Angler effort concentrates on the 1.5-mile section of river from the Richardson Highway bridge downriver to the confluence of the Salcha River and the Tanana River. A total of 72 anglers was interviewed during five interview periods while the chinook salmon were running. The anglers had in their possession or had previously taken 25 chinooks, for a catch of 0.35 fish/angler--nearly identical to catch rates of 0.33 fish/angler in 1979, 0.34 fish/angler in 1982, and 0.37 fish/angler in 1983.

A total of 45 angler counts was made in the lower river while chinooks were available and the river was fishable. Counts ranged from 3 anglers to 34 anglers, and the mean number of anglers seen was 14.

A sport-fishing, boat-charter service operated on the lower Salcha during the chinook run. They assisted the Department by making angler counts and keeping records on river conditions, catch rate and effort for their patrons, and counts of chinook salmon taken by other parties. Weight and sex were recorded for all chinooks they caught and kept, and weight was estimated for all fish that they released or that they saw others take. Their clients took a total of 27 chinooks in 334 hours of angling, for a CPUE of 0.08 fish/h, compared to their catch of 61 chinooks in 1983, for a CPUE of 0.13 fish/h. Of the 27 chinook salmon taken, 11 fish were released.

Combined ADF&G and charter-service counts produced a documented catch of 77 chinooks, compared to a total of 131 chinooks in 1983. The weight range (weighed or estimated) of the 60 fish was 5-27 lb (weight, 15 lb). Mean weight of fish taken in the 1983 sport fishery was 12 lb (n = 99). Of the 16 fish for which sex was positively determined, 10 fish (62%) were males. In 1983, males made up 60% of the take.

Winter Studies:

Salcha River winter investigations were begun in February 1983 and continued in March 1984. The goal is to gather information on winter fish-species composition, distribution, and habitat in the river.

Dissolved oxygen levels were sampled in five locations between Redmond Creek and the Richardson Highway bridge. Levels ranged from 4.0 ppm in backwater sloughs to 7.5 ppm in the main current. Bendock (1975) reported December DO levels in Redmond Creek ranging from 1 ppm to 2 ppm.

A 125-ft monofilament, graduated-mesh gill net that was set for 48 h in the main river just above the confluence with the Tanana took one round whitefish. The net did not fish because an accumulation of rootlets, leaves, and debris clogged it. There was about 5 ft of water under 3 ft of ice.

A 30-ft monofilament gill net consisting of 10-ft panels of 0.5 in., 1-in., and 1.5-in. bar mesh was set in a backwater 1.5 miles above the Richardson Highway bridge. Two net nights of effort produced one humpback whitefish. The presence of burbot was documented by the use of setlines at this location.

LITERATURE CITED

Alt, K.T. 1977. Inventory and cataloging of sport fish and sport fish waters of western Alaska. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Report of Progress, 1976-1977, Project F-9-9, 18(G-I-P): 128 p.

Bendock, T. 1975. Fisheries investigations on the Salcha and Tanana River drainages, preliminary findings. Joint State/Federal Fish and Wildlife Advisory Team. First Interim Report of the Sport Fish Technical Evaluation Study. Special Report Number 6. Alaska Department of Fish and Game, Division of Sport Fish, Fairbanks, Alaska.

Doxey, M. 1980. Population studies of game fish and evaluation of managed lakes in the Salcha District with emphasis on Birch Lake. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Report of Progress, 1979-1980, Project F-9-12, 21(G-III-K): p. 26-47.

_____. 1981. Population studies of game fish and evaluation of managed lakes in the Salcha District with emphasis on Birch Lake. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Report of Progress, 1980-1981, Project F-9-13, 22(G-III-K): p. 38-59.

_____. 1982. Population studies of game fish and evaluation of managed lakes in the Salcha District with emphasis on Birch Lake. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Report of Progress, 1981-1982, Project F-9-14, 23(G-III-K): p. 30-49.

_____. 1983. Population studies of game fish and evaluation of managed lakes in the Salcha District with emphasis on Birch Lake. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Report of Progress, 1982-1983, Project F-9-15, 24(G-III-K): p. 39-66.

_____. 1984. Population studies of game fish and evaluation of managed lakes in the Salcha District with emphasis on Birch Lake. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Report of Progress, 1983-1984, Project F-9-16, 25(G-III-K): p. 26-51.

Hallberg, J.E. 1979. Evaluation of management practices on four selected lakes of interior Alaska. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Report of Progress, 1979-1980, Project F-9-11, 20(G-III-J): p. 115-134.

Kramer, M.J. 1978. Evaluation of Interior waters and sport fish with emphasis on managed lakes--Fairbanks District. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Report of Progress, 1977-1978, Project F-9-10, 19(G-III-H): p. 46-62.

Miller, R.B., and H.W. Kennedy. 1948. Observations on the lake trout of Great Bear Lake. J. Fish Res. Board Can. 7:190-199.

Roguski, E.A., and P.C. Winslow. 1969. Investigations of the Tanana River and Tangle Lakes grayling fisheries: migratory and population study. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Report of Progress, 1969-1970, Project F-9-1, 10(16-B): p. 33-351.

Van Hulle, F.D. 1968. Investigations of the fish populations in the Chena River. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Report of Progress, 1967-1968, Project F-5-R-9, 9: p. 287-304.

Van Wyhe, G., and J. Peck. 1968. A limnological survey of Paxson and Summit Lakes in Interior Alaska. Alaska Department of Fish and Game, Informational Leaflet No. 124. 40p.

Prepared by:

Michael Doxey
Fishery Biologist

Approved by:

E. Richard Logan, Ph.D., Director
Division of Sport Fish

Louis S. Bandirola, Deputy Director
Division of Sport Fish